Technical Memorandum

Refinements to Human Health Exposure Assumptions
Conceptual Site Model/Problem Formulation
Lower Passaic River Restoration Project
March 3, 2006

This technical memorandum provides a summary of the supplemental activities conducted to refine certain exposure parameter assumptions that will be used to conduct the human health risk assessment (HHRA) for the Lower Passaic River Restoration Project. Preliminary exposure parameter values were provided in the Pathways Analysis Report (PAR) (Battelle, 2005); however additional data gathering and evaluation have been conducted to provide more site specific values for incorporation in HHRA. The refined exposure values also are provided in this technical memorandum. Please note that some exposure parameters will require additional refinement based on the results of the New Jersey Department of Environmental Protection (NJDEP) angler surveys[1] that U.S. EPA anticipates receiving soon. This work will be completed under an additional task order. The exposure assumptions focused on in this Technical Memorandum include:

- Exposure duration
- Cooking preparation/loss
- Identification of fish species for consumption
- Consumption rate

HUMAN HEALTH EXPOSURE PARAMETERS

a. Exposure Duration. The PAR recommended a 30-year default value for exposure duration for the angler/sportsman and the recreational user, representing an upper bound residential tenure at a single location. These two receptors are assumed to be fairly permanent residents in the area, as opposed to the homeless resident receptors who are expected to be much more transient individuals. As a means to develop a site-specific exposure duration for the angler/sportsman and recreational user, the U.S. Census data for the areas surrounding the Lower Passaic River were used to estimate the number of years local individuals reside along the river.

The objective of the evaluation is to estimate the residence duration within a particular region using U.S. Census data (U.S. Census Bureau, 2000). It is assumed that the population of concern consists of towns and cities and rural areas within seven New Jersey (NJ) counties: Bergen, Essex, Hudson, Morris, Passaic, Somerset, and Union County. Basically, the evaluation quantified (1) how long residents are staying within their county and (2) how long residents stay within the region (*i.e.*, the seven county area).

The distribution of the length of time remaining until an individual moves out of a particular region or county is given by estimating the one-year probability that an individual will move out of the region/county, and then combining these one-year probabilities to calculate the likelihood that an individual will move out of the area over a more extended time period.

Table 1 presents the migration data for the seven counties and Table 2 displays the estimated one-year probabilities of moving and associated statistics (*i.e.*, the 50th and 95th percentiles of projected residence

[1] U.S. EPA has been in contact with the NJDEP regarding results of their angler surveys. NJDEP is in the process of querying their data for specific data needs requested by U.S. EPA

times within each county and the region). The median number of years for an individual to move out of the whole region, consisting of seven counties, is approximately 21 years, and for individual counties, ranges from approximately 11 years to 16 years. Observing that the median number of years for an individual to move out of the region is demonstrably higher than that for any individual county suggests that there is non-trivial mobility of the population among the seven counties within the region. Figure 1 provides a histogram of the residence duration for the entire region consisting of seven counties.

Note that these exposure duration values have not been adjusted for fishing duration. It is anticipated that once the survey data from NJDEP are obtained, specific information regarding age fishing began and number of years fished within the Newark Bay area will help to refine the exposure duration for the angler/sportsman. The census evaluation results only account for residence time, not length of time fishing at the residence. One would expect that a person fishes less time in a particular location than that person resides in that location. Therefore, the census data evaluation will be adjusted to account for fishing duration when that data become available. In the interim, information obtained from the NJDEP's Division of Fish and Wildlife 2003 angler survey (Responsive Management, 2003) are provided in Figures 2 through 5. These figures summarize information on the age the respondents began fishing, the number of years fishing, the current age of the respondents, and the hours the respondents traveled to fish, respectively. This angler survey is based on the entire state of New Jersey, whereas the NJDEP survey focuses on the Newark Bay Complex area, which includes specific portions of the Lower Passaic River. Therefore, the use of the results from the NJDEP survey would result in a more site-specific exposure duration for the receptor evaluated in the Lower Passaic River risk assessment.

Table 1. Migration Data for Seven Counties of New Jersey

County	Gross Migration for the Population 5 Years and Over for U.S.[a]		OutFlow [b]		
	Same residence (nonmovers)	Different Residence in same geographic area (movers within county)	Movers Within the Region [c]	Movers Outside Region [c]	Total Movers out of the County
Bergen	520,504	159,955	38,590	100,669	139,259
Essex	426,607	186,082	51,745	86,470	138,215
Hudson	307,247	142,143	41,658	70,936	112,594
Morris	267,435	71,653	18,000	69,897	87,897
Passaic	268,889	111,246	33,003	46,909	79,912
Somerset	152,788	42,384	9,372	51,263	60,635
Union	295,644	96,351	26,759	70,463	97,222
Region (All 7 Counties of NJ - Bergen, Essex, Hudson, Morris, Passaic, Somerset, and Union)	**2,239,114**	**809,814**	**219,127**	**496,607**	

Notes:
a. Source: Gross Migration for the Population 5 Years and Over for the United States, Regions, States, Counties, New England Minor Civil Divisions, and Metropolitan Areas: 2000 (http://www.census.gov/population/cen2000/phc-t22/tab01.xls)
b. Source: County-to-County Outflow Files. The outflow file contains FIPS codes of previous residence (in 1995) and current residence (in 2000), as well as the number of migrants who moved between those two counties (flow). (http://www.census.gov/population/cen2000/ctytoctyflow/outtxt_flow.txt)
c. Region: Bergen, Essex, Hudson, Morris, Passaic, Somerset, and Union Counties.

Table 2. Distribution of Time Remaining Until An Individual Moves Out

County	Population Tracked [a]	Probability of Moving in 5 Year Span	Probability of Moving in 1 Year Span	Projected Residence Time: 50th Percentile (Years)	Projected Residence Time: 95th Percentile (Years)
Bergen	819,718	0.1699	0.0455	15.9	65.4
Essex	750,904	0.1841	0.0496	14.6	59.9
Hudson	561,984	0.2004	0.0544	13.4	54.6
Morris	426,985	0.2059	0.0560	13.0	53.0
Passaic	460,047	0.1737	0.0466	15.5	63.8
Somerset	255,807	0.2370	0.0654	11.2	45.3
Union	489,217	0.1987	0.0539	13.5	55.1
Region (Bergen, Essex, Hudson, Passaic, Morris, Somerset, and Union Counties)	**3,764,662**	**0.1319**	**0.0347**	**20.6**	**85.7**

[a] By County: Nonmovers + Movers Within the County + Total Movers Out of the County
By Region: Nonmovers + Movers Within the County + Movers within the Region + Movers Out of the Region.

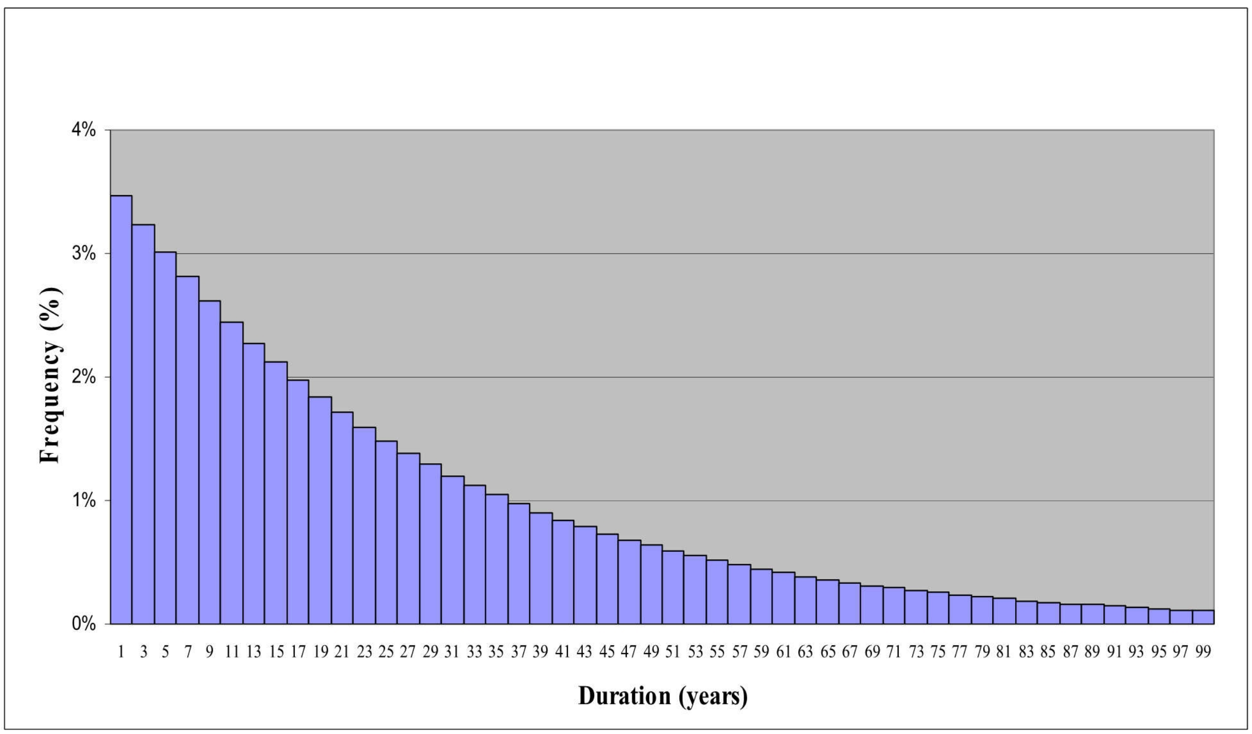

Figure 1. Residence Duration within a Seven County Region in NJ

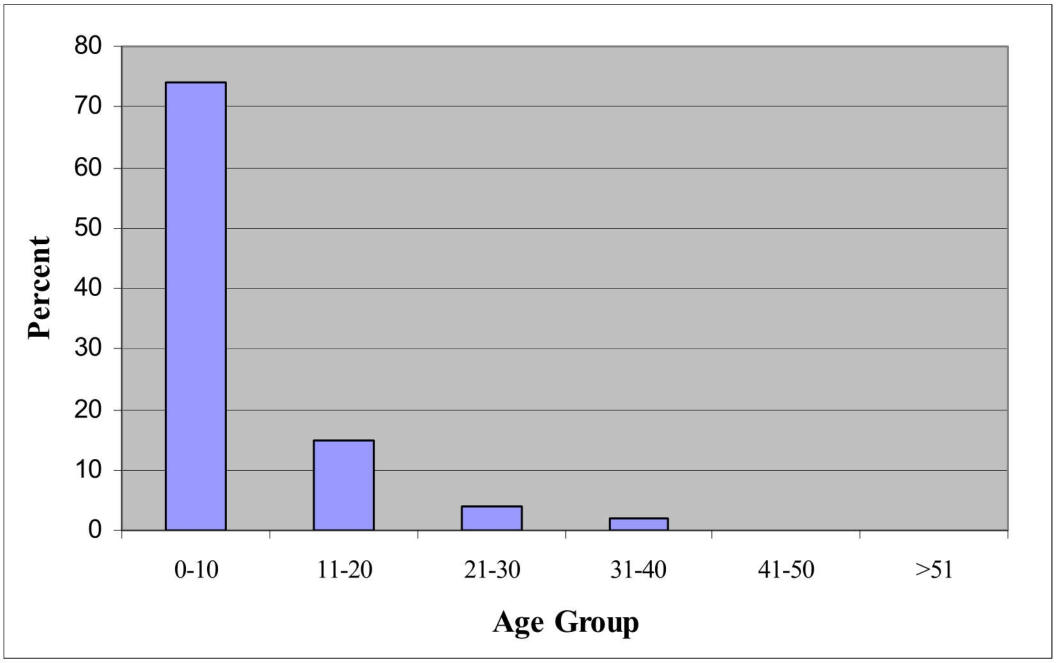

Figure 2. Reported Age Individuals Began Fishing (n=802) (Responsive Management, 2003)

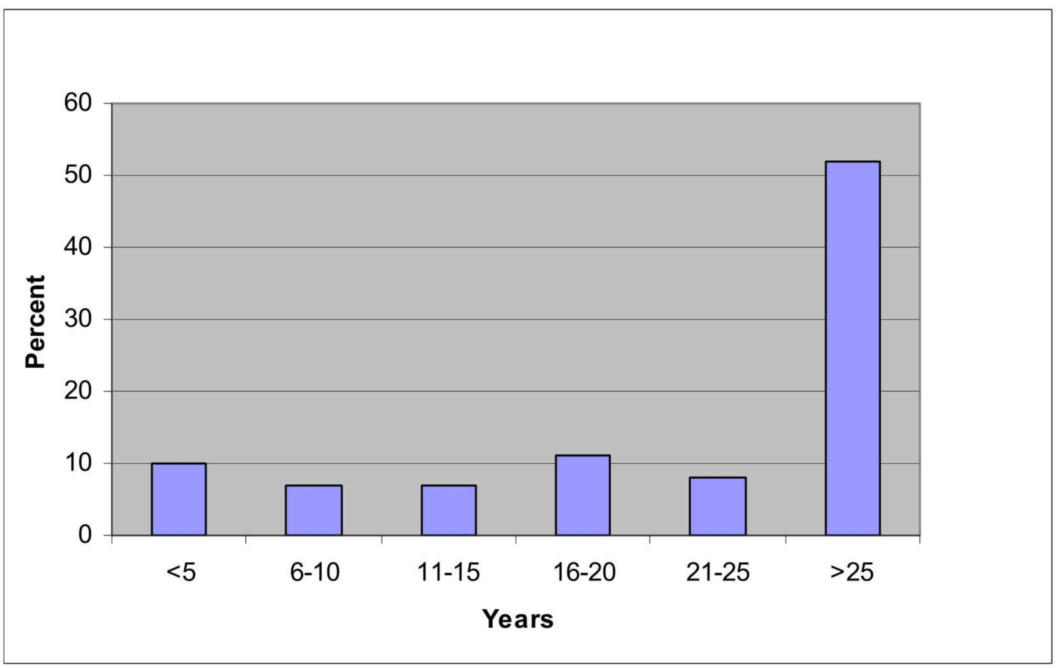

Figure 3. Reported Number of Years Individual has Fished (n=805) (Responsive Management, 2003)

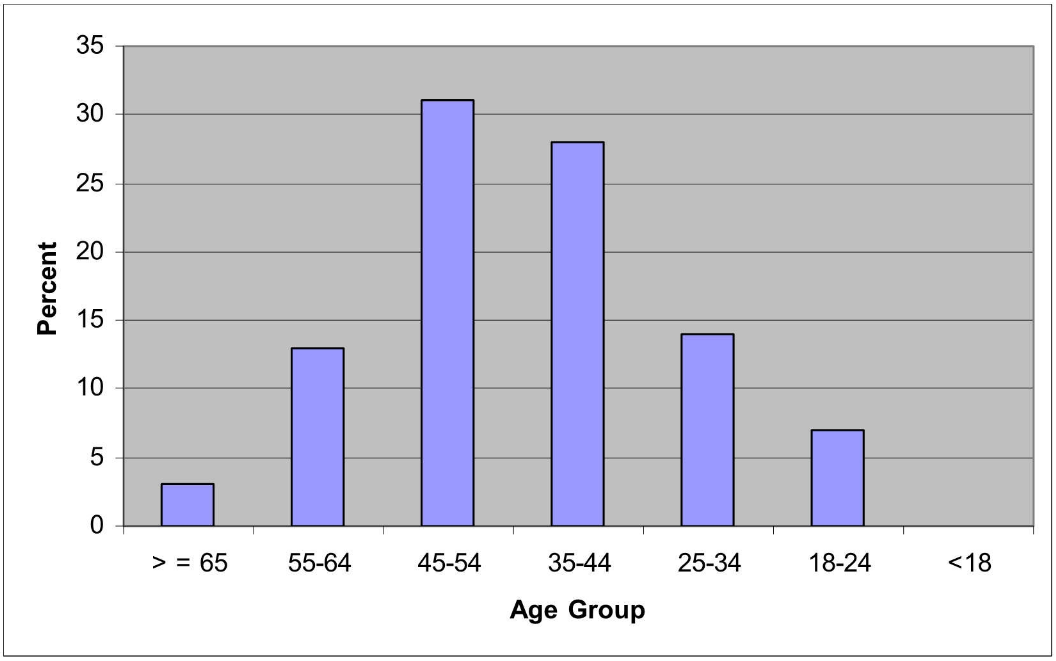

Figure 4. Current Age Distribution of the Survey Respondents (Responsive Management, 2003)

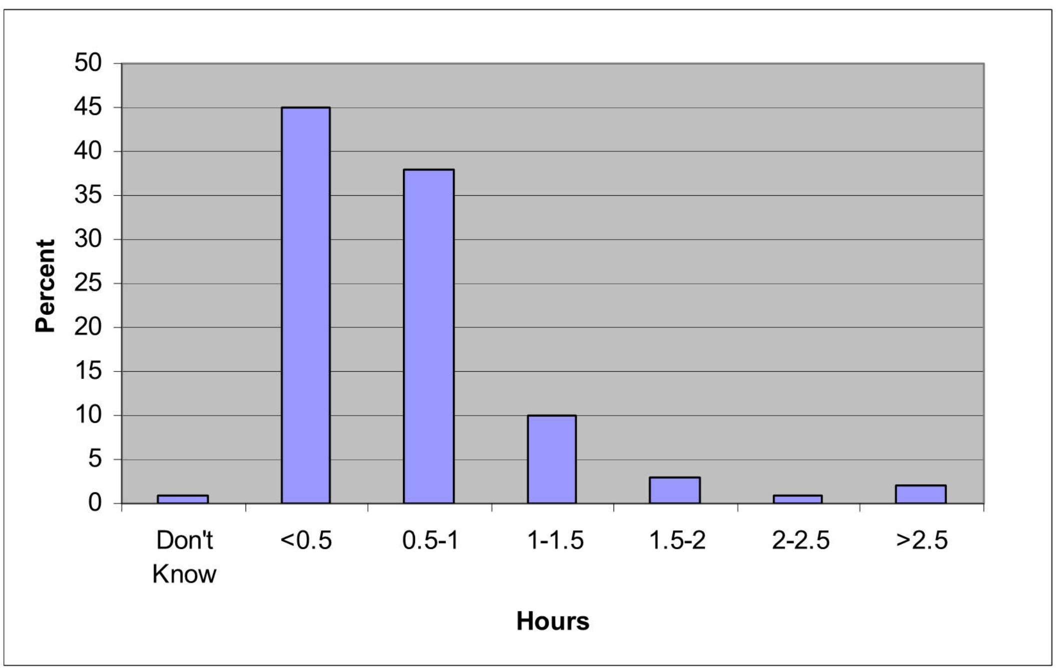

Figure 5. Number of Hours One Travels to Fish (n=806) (Responsive Management, 2003)

b. Cooking Preparation/Loss. Fish preparation and cooking procedures can modify the amount of contaminant ingested by fish consumers consequently modifying exposure and dose. Several studies have been conducted in an attempt to quantify this modification and a variety of factors have been investigated including the species of fish, preparation method (*e.g.*, skin-on vs. skin-off), cooking method (baking, broiling, deep frying, etc.), fattiness of the fish sampled (within the same species), and waterbody where the fish were collected. The U.S. EPA (2000) summarized the percent reductions of organic contaminants resulting from preparation method, cooking method, species and location. The range of reduction percentages for the chemicals of potential concern (COPCs) identified in the Draft Final Pathways Analysis Report (Battelle, 2005) is summarized in Table 3, with the exception of PCBs. These studies show wide ranges in the percentage of reduction for each of the chemicals investigated. Thus, it is difficult to select a reduction factor that can be applied for a particular chemical. Only a few of the COPCs were included in the cooking loss studies. Summary statistics of the range of reduction percentages for the few COPCs are summarized in Table 4. Note that Table 4 summarizes the percent loss values for skin-on, skin-off, and combined fish preparation skin-on/skin-off. Because there were no consistent differences in contaminant losses between cooking methods, the results were only grouped according to contaminant, and not by cooking method.

For this particular review of cooking loss, PCBs were not included because numerous studies regarding PCB cooking loss were evaluated in the HHRA for the Hudson River (TAMS/Gradient Corp., 2000). The 12 studies reviewed in the Hudson River HHRA regarding cooking loss found that cooking loss ranged from 0 to 74% with most PCB losses between 10% and 40%. Based on the results provided in the Hudson River risk assessment, the U.S. EPA Region 2 risk assessor recommended the use of 20% as the cooking loss factor for the central tendency exposure (CTE), noting that the value of 20% is midpoint between 0% to 40%, and the use of 0% cooking loss for the reasonable maximum exposure (RME).

Generally, chemical contaminants are not distributed uniformly in fish. Fatty tissues, for example, will concentrate many organic chemicals more readily than muscle tissue. For those chemicals that accumulate in the fatty tissues, removing the skin and fat that collects beneath the skin and along the lateral line will reduce contaminant exposure. Also, to make adjustments to dose accurately, it is important to match the dose modification factors to the type of sample from which the fish contaminant concentrations was measured. For example, it would not be appropriate to apply a modification factor based on removal of skin if the sample analyzed was already a "skin-off" fillet.

The U.S. EPA Exposure Factors Handbook (EFH) (U.S. EPA, 1997) provides a recommended default adjustment for cooking and preparation loss. The values given in Table 13-5 of the EFH for fish are 30% for Mean Net Cooking Loss (includes dripping and volatile losses during cooking, averaged over various cuts and preparation methods) and 11% for Mean Net Post Cooking Loss (includes losses from cutting, shrinkage, excess fat, bones, scraps and juices, averaged over various cuts and preparation methods). The EFH recommends that the modified intake rates be calculated as:

$$I_A = I \times (1 - L_1) \times (1 - L_2) \qquad (1)$$

Table 3. Summary of Contaminant Loss from Fish Due to Cooking [a]

Contaminant	Study	Preparation Method	Percent Loss Value
DDD	Zabik et al. 1995b; 1996	Skin off	4 to 88
DDD	Zabik et al. 1995b	Skin on	10 to 54
DDE	Zabik et al. 1995b; 1996	Skin off	7 to 61
DDE	Zabik et al. 1995	Skin on	16 to 59
DDE	Skea et al. 1979	Trimmed	52 to 54
DDT	Zabik et al. 1994; 1995b; 1996	Skin off	1 to 80
DDT	Zabik et al. 1994; 1995b	Skin on	23 to 60
DDT	Reinert et al. 1972; Zabik et al. 1994	Trimming/Skin off	1 to 62
DDT	Zabik et al. 1994	Skin on	4 to 16
Dieldrin	Zabik et al. 1994; 1995a; 1995b; 1996	Skin off	4 to 88
Dieldrin	Zabik et al. 1994; 1995°; 1995b	Skin on	3 to 93
α-Chlordane	Zabik et al. 1994; 1995b; 1996	Skin off	3 to 63
α-Chlordane	Zabik et al. 1994;1995b	Skin on	(-)25 to 63
γ-Chlordane	Zabik et al. 1995b: 1996	Skin off	1 to 83
γ-Chlordane	Zabik et al. 1995b	Skin on	20 to 50
Chlordane Complex	Zabik et al. 1995a	Skin on	3 to 60
TCDD	Zabik and Zabik 1995	Skin off	54 to 57 (approx.)
TCDD	Zabik and Zabik 1995	Skin on	37 to 80 (approx)

(a) Source: U.S. EPA, 2000

Table 4. Summary Statistics for Contaminant Percent Loss[(a)] from Fish Due to Cooking

COPC [(b)]	Skin Off					Skin On					Combined [(c)]				
	Minimum	Average	50th Percentile	90th Percentile	Maximum	Minimum	Average	50th Percentile	90th Percentile	Maximum	Minimum	Average	50th Percentile	90th Percentile	Maximum
DDD	4	30	19	61	88	10	37	36	54	54	4	31	30	58	88
DDE	7	30	27	52	75	7	39	39	49	59	7	32	35	52	75
DDT	0	38	30	69	141	4	33	29	58	60	0	37	30	64	141
Chlordane	1	29	30	51	83	3	38	38	52	63	1	32	33	51	83
Dieldrin	4	29	25	52	88	3	36	38	58	93	3	32	30	55	93
TCDD	54	56	56	57	57	37	51	44	69	80	37	53	49	69	80

Source: U.S. EPA, 2000

(a) Percent losses are derived by combining all cooking methods
(b) Contaminants have all been grouped under one heading. For example, alpha chlordane and gamma chlordane results have been combined summarized as “chlordane”. Similarly for p,p’-DDx, each has been compiled within DDD, DDE, or DDT, respectively.
(c) Combined includes both skin-on and skin-off results

Where:

I_A = Adjusted Intake Rate
I = Intake Rate
L_1 = Cooking Loss
L_2 = Post-Cooking Loss

By applying the mean percent weight losses presented in the EFH (Table 13-5), the adjusted intake rate is calculated as follows:

$$I_A = I \times (1 - 0.30) \times (1 - 0.11) \qquad (2)$$

$$I_A = I \times 0.7 \times 0.89 \qquad (3)$$

$$I_A = I \times 0.62 \qquad (4)$$

Thus, the total cooking loss and preparation adjustment amounts to 38%. Note that the mean cooking loss percentages are based on averages over a variety of fish, including bass, bluefish, butterfish, cod, flounder, haddock, halibut, lake trout, mackerel, perch, porgy, red snapper, rockfish, salmon, sea trout, shad, smelt, sole, spot, squid, swordfish steak, trout, and whitefish.

In general, for heavy metals, tissue residues are not significantly reduced by processing or cooking methods. Therefore, preparation and cooking loss adjustments should not be applied for metals in most cases (U.S. EPA, 2000), except mercury, as discussed below.

Table 5 summarizes the proposed range of cooking losses to be examined in the future Lower Passaic River risk assessment. For RME a cooking loss of 0% is proposed for all COPCs to be consistent with the PCB cooking loss. For CTE, the 50th percentile cooking loss percent value for skin-off presented in Table 4 is proposed (*i.e.*, assuming fillets are eaten). For other organic compounds not listed in Table 4, 0% cooking loss is proposed for the RME, and the CTE estimate is proposed to be derived using the default adjustment provided in the U.S. EPA EFH (U.S. EPA, 1997).

Mercury binds strongly to proteins and thus concentrates in the muscle tissue of the fish. It also concentrates in the liver and kidneys, although to a lesser extent (U.S. EPA, 2000). Several studies on the effects of preparation and cooking on mercury have shown that mercury concentrations are less in raw fish than in cooked fish, although the total amounts of mercury remain the same. The higher concentrations are attributed to the loss of liquid and fat during cooking results in a higher concentration. Morgan et al. (1997) found that mercury concentrations in pan-fried, baked, and broiled walleye fillets and deep-fried and baked whitefish livers ranged from 1.1 to 1.5 times higher than corresponding raw portions. In lake trout, mercury concentrations were 1.5 to 2.0 times higher in smoked fish than in the raw portions. Burger et al. (2003) calculated preparation factors of 1.5 to 1.8 for deep fried large mouth bass. Burger et al. (2003) concluded that based on these two studies, a preparation factor of 2 would be a suitable, protective default for estimating safe consumption levels. For mercury, it is proposed that the RME estimate will include a preparation factor of 2, and for the CT estimate a preparation factor of 1.

Due to lack of information, the cooking loss for crab will be assumed to be 0%.

Table 5. Proposed Range of Cooking Loss for the Lower Passaic Risk Assessment

Contaminant	Exposure Scenario	
	RME (%)	**CTE (%)**
DDD	0	19
DDE	0	27
DDT	0	30
Chlordane	0	30
Dieldrin	0	25
TCDD	0	56
PCBs	0	20
Other organic compounds	0	38[(a)]
Metals	0[(b)]	0[(b)]

RME – reasonable maximum exposure; CTE – central tendency exposure
(a) The U.S. EPA Exposure Factors Handbook (EFH) (U.S. EPA, 1997) provides a recommended default adjustment for cooking and preparation loss. The values given in Table 13-5 of the EFH for fish are 30% for Mean Net Cooking Loss and 11% for Mean Net Post Cooking Loss (refer to equations 1 through 4 above).
(b) Preparation and cooking loss adjustments should not be applied for metals in most cases (U.S. EPA, 2000). Conversely, concentrations of mercury in protein tend to increase upon cooking; therefore, a preparation factor of 2 is recommended for this metal.

c. Identification of Fish Species for Consumption. To account for possible species preferences in human consumption of fish, a review of available information was conducted to evaluate whether different species are preferentially targeted by anglers in the Lower Passaic River Study Area. Information reviewed included fishing licenses, angler surveys, and other information obtained for the study area. Table 6 summarizes fish species by area along the 17-mile stretch of the Passaic River.

In addition, the NJDEP's "Routine Monitoring Program" report [available at http://www.state.nj.us/dep/dsr/njmainfish.htm (under "Current Research")] was reviewed to identify the fish species in the Lower Passaic River of interest to NJDEP. Generally, all species downriver of the Dundee Dam are under advisory. The NJDEP 1995 angler survey, which was distributed to individuals fishing in the Newark Bay Complex area, including parts of the Lower Passaic River, was prepared with the objective of determining the frequency of ingestion of these fish species: striped bass, bluefish, white perch, white catfish, and American eel. Of 22 survey respondents from the Passaic River Portion (Nutley Bridge and Lyndhurst Boat Ramp areas), all five fish species were caught, but only striped bass was reported to be consumed. Desvousges et al. (2001) conducted a creel/angler study of the lower six miles of the Passaic River. Of 107 fish caught and kept, 56% were white perch, 6.5% striped bass, 16.8% eel, 6.5% catfish, and 6.5% carp. The majority of anglers who kept their catch intended to consume it.

Table 6. Fish Species Located Along the Lower Passaic River

Brackish Section	Sampling Locations	Cooking Method (3,2)	Parts consumed (3)
Common carp (4)	Lower 6 miles (4, 6)	Fried	head, tail, body, skin
Channel catfish (4)		Fried, other	body, tail
Bluefish (5)			
Blue crab (5,3)		Boiled, fried, steamed	legs, claws, body
American eel (4)		Fried, smoked	body, tail, skin
Striped bass (4)		Fried, other	body, skin
White perch (4)		Fried, other	head, body
Atlantic menhaden (4)			
Brown bullhead (4)			
Weakfish (6)			
Gizzard shad (6)			
Transitional Section	Lyndhurst, Eagle Rock Ave (1)		
Northern Pike (1)			
Common carp (1)		Fried	head, tail, body, skin
Black crappie (1)			
Largemouth bass (1)			
Striped bass (1)		Fried, other	body, skin
American eel (1)		Fried, smoked	body, tail, skin
Channel catfish (1)		Fried, other	body, tail
Freshwater Section	Garfield, Elmwood, Dundee (1)		
Brown bullhead (1)			
Largemouth bass (1)			
American eel (1)		Fried, smoked	body, tail, skin
Yellow bullhead (1)			
Common carp (1)		Fried	head, tail, body, skin
Striped bass (1)		Fried, other	body, skin
White sucker (1)			
Channel catfish (1)		Fried, other	body, tail
Redbreast sunfish (1)			
Bluegill (1)			

(highlighted) common to all areas

1) Horwitz, R., J. Ashley, P. Overbeck, and D. Velinsky. 2005. Final Report: Routine Monitoring Program for Toxics in Fish. Submitted to NJ Dept of Environmental Protection, Division of Science Research and Technology. Patrick Center for Environmental Research. Academy of Natural Sciences. Philadelphia, PA. May 16, 2005. http://www.state.nj.us/dep/dsr/final-report-routinemonitoing5-05.pdf
2) May, H. and J. Burger. 1996. Fishing in a Polluted Estuary: Fishing Behavior, Fish Consumption, and Potential Risk. Risk Analysis Vol. 16 No. 4 p 459-471.
3) Desvousges, W., J. Kinnell, K. Lievense, and E. Keohane. 2001. Passaic River Study Area Creel/Angler Survey: Data Report. Prepared by Triangle Economic Research. Project No. 75-FR.
4) ChemRisk. 1995. Draft Passaic River Screening-Level HERA. July 6, 1995. P. 4-17a.
5) Statewide and Regional Fish Consumption Recommendations to Reduce Exposure to Dioxin, PCBs, and Mercury. Brochure developed by NJDEP. Available at: http://www.state.nj.us/dep/dsr/FishAdvisory.pdf
6) Iannuzzi, T. and D. Ludwig. 2004. Historical and Current Ecology of the Lower Passaic River. Urban Habitats. Vol 2, No. 1 147-173.

Burger et al. (1999) reported differences in the species of fish being consumed by ethnic group. A higher percentage of Hispanics reportedly consumed more crab than whites or blacks, and a higher percentage of blacks ate more bluefish or striped bass than the other groups.

For purposes of the risk assessment, it would be wise to include those fish species common to all parts of the river and species commonly eaten as reported in angler/creel surveys of the surrounding Passaic River area. Given that data from the 1995 (and subsequent) angler surveys conducted by NJDEP have not yet been received by U.S. EPA, it is recommended that at this point in time, at least the following fish are identified for consumption: white perch, striped bass, American eel, catfish (in general), and bluefish. It is anticipated that the data from the NJDEP will help narrow down the list of fish. It is suggested that the common species eaten based on the results of the survey, in addition to type of fish (*i.e.*, bottom feeders, various fat content), be used to identify the fish species of interest for the risk assessment. Therefore, additional refinement of this exposure assumption depends on the NJDEP angler survey results.

d. Consumption Rate. The fish consumption rate is based on the amount of fish an individual consumes on average in one year, but the rate presented here is based on grams of fish eaten per day (g/day) to agree with daily rates of the other risk assessment exposure parameters. Consumption studies provided by U.S. EPA were reviewed to identify fish and crab consumption rates. Some of the fish consumption rate literature for freshwater fishing is summarized below. Table 7 summarizes the various consumption rates obtained from literature sources directly pertaining to the Passaic River and/or the Newark Bay Complex Area. Note that none of the literature sources contained consumption rates specific to children, and specific fish species consumed were also not provided in these literature sources.

- *1992 Lake Ontario Questionnaire (Connelly et al., 1992*). In January 1992 a questionnaire was mailed to 2,000 anglers with New York State fishing licenses for the year beginning October 1, 1990 through September 30, 1991. The focus of this study was on awareness of fish consumption advisories. Additional information that was collected included species of fish caught and consumed in 1991 by location and methods of fish preparation. Of the 2,000 licensed New York anglers, 1,030 questionnaires were completed. The overall average number of sport-caught fish meals per year was 11. By assuming 150 g as the average amount of fish consumed per meal, the sport-caught fish consumption rate would be 4.5 g/day. However, if 330 g is assumed as the average amount of fish consumed per meal as reported by May and Burger (1996), the sport-caught fish consumption rate would be 9.9 g/day. The fish consumption rate at the 50th percentile was 4.0 g/day and at the 95th percentile was 63.4 g/day.

- *1992 Lake Ontario Diary Study (Connelly et al., 1996).* In 1992, a sample of 2,500 names was chosen from persons obtaining a 1990-1991 fishing license in six New York counties bordering Lake Ontario. Study participants were mailed a questionnaire asking to recall 1991 fishing trips and other information. They were also asked to keep a diary of fish consumption and fishing trips to Lake Ontario and other New York waters during 1992. In addition, periodic phone interviews were conducted to collect diary entries and a final phone interview was conducted to study the awareness of health advisories. Participants were asked to record species of fish eaten, the size of their fish meal, method of acquiring fish, fish preparation techniques, and the number of household members sharing the fish. Of the 2,500 anglers in the random sample, 853 license buyers either returned the diary or provided diary information by telephone, and only 366 indicated that they had fished in Lake Ontario during 1992. Results are based on participation of these 366 people. The mean fish consumption rate was 17.9 g/day and the mean sport-caught fish consumption rate was 4.9 g/day. The 95th percentiles were 42.3 g/day for fish consumption from all sources and 17.9 g/day from sport-caught fish.

- *U.S. EPA Exposure Factors Handbook (U.S. EPA, 1997).* The recommended mean and 95th percentile values for recreational freshwater anglers are 8 g/day and 25 g/day respectively. These were derived by averaging the values from the three populations surveyed in the key studies: mailed questionnaire surveys (Ebert et al., 1993 and West et al., 1989; 1993) and the diary study (Connelly et al., 1992; 1996).

NJDEP conducted two angler surveys, one in 1995 and another in 2005, in the Newark Bay complex area to see the effects of fishing advisories on individuals that fished and crabbed in this area. The surveys focused on five fish species (*i.e.*, those with advisories) and crabs at various locations throughout the Newark Bay complex. A total of 300 surveys were completed in 1995 and 200 surveys were completed in 2005. In addition to demographic data, the surveys asked questions regarding frequency of fishing, fish species caught and consumed, number of meals eaten, amount eaten at meals, and if others in the household ate the catch as well. It is anticipated that once these data are obtained from NJDEP, more site specific consumption rates may be able to be derived for use in the Passaic River risk assessment. Therefore, site-specific consumption rates have not yet been developed.

Table 7. Summary of Fish and Crab Consumption Values Reported in the Literature Specific for the Newark Bay Complex Area

Consumption Rates	PRSA Creel/Angler Survey 2001 (Desvousges et al., 2001)	NJDEP Urban Angler Survey, 1995	May and Burger, 1996	Pflugh and Kerry, 2002	Hudson River Risk Assessment (TAMS and Gradient, 2000)	Burger, 2002
Fish	Can't derive consumption rates, but know: • How often they fish per month • Fish species caught and eaten • Length of fish • Part of fish consumed • Cooking method	Identifies fish caught. Only one respondent out of 22 ate his catch. Respondent stated that he (and other adults in household) eat fish once per year and eat about ½ to 1 pound per meal. They have been eating fish they catch for about 4 years.	Average: 52.8 g/day Worst Case: 220 g/day However, 60% reported buying more than ½ the fish eaten, and fishing reported to occur in the warmer months (*i.e.*, 6 months) so can adjust average and worst case consumption rates to: Average: 11 g/day Worst case: 44 g/day	No fish information provided.	50th percentile: 4.0 g/day (6.4 fish meals/yr) 90th percentile: 31.9 g/day (51 fish meals/yr) Risk assessment assumed ½ pound servings. Risk assessment assumed the child rate to be 1/3 of adult's rate and the adolescent rate to be 2/3 of adult's rate.	Yearly (all fish only): 8,120 grams ± 2,040 grams Yearly (all fish and crab): 13,600 grams ± 3,480 grams
Crab	Crabs were not eaten	Only one respondent out of 22 ate crab catch (the same respondent who ate the fish). Respondent stated that he (and other adults in household) eat crab two times per month and eat about six crabs per meal. They have been eating crab they catch for about 4 years.	Average: 187 g/day Worst Case: 810 g/day (60% crabbers report over 75% of crabs eaten are caught)	Provides frequency of crab consumption, number of crabs eaten per meal, and average serving size of crab. Example: One crab meal per month, 3 crabs per meal, 75 grams per crab (including hepatopancreas): 7.5 g/day Worst case: 6 meals/week; 15 crabs per meal, 75 g/crab: 225 g/day.	No information provided.	Same as above.
Data Gaps	• No portion sizes given • Not asked about frequency of consuming catch • Only adults • Issues with how surveys were administered	• Only 22 surveys • Only 1 respondent ate his catch (striped bass and crabs)	• Ingestion rates for adults • Fish species not identified • Not specific to Passaic River	• Ingestion rates for adults only, no child rates • Fish consumption not discussed • Not specific to Passaic River	• Consumption rate not based on a specific fish species • Not specific to Passaic River	• Consumption rate not based on a specific fish species • Children not interviewed

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